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EPAct Testing Status

CRC Emissions Committee Meeting

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EPAct Test Programs

- Light Duty Gas Exhaust Fuels (SwRI)
- Oil Study (NVFEL)
- PM Speciation (ORD NRMRL/NVFEL)
- Nonroad Exhaust (Intertek Carnot)
- Evap, E-77-2b (SwRI)
- Percent of High Evap in Fleet, E-77-3 (Colorado/Texas)

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Background: Program, Reason, Usage

- Light Duty Exhaust Fuels (\$4M EPA, \$2M DOE, \$160K CRC)
 - Reason: Impact of ETOH and fuel properties on Tier 2 exhaust emissions
 - Usage: MOVES and Complex model, EISA, CMAQ, PM source apportionment
 - RFS2 NPRM (freeze data July, 2008) - E10, E15 discussion, temperature impacts
- Oil PM Study
 - Reason: Determine oil age and ETOH interaction impact on PM
 - Usage: Support of LDEF and future MOVES PM oil age relationship
 - LDEF vehicle mileage requirements for oil stability
 - Oil change requirements between ETOH blends
- PM Speciation
 - Reason: Impact of ETOH on Tier 2 vehicle PM and VOC speciation profiles, metals
 - Usage: CMAQ and other modeling, source apportionment work
- Non-Road Exhaust
 - Reason: Impact of ETOH on sample of non-road engine exhaust
 - Usage: MOVES (general data need) to support:
 - Early data for RFS2 NPRM
- Evaporative Testing (\$1.5M)
 - Reason: Impact of ETOH on Tier 2 near zero and determine % fleet malfunctioning
 - Usage: MOVES (general data need) and to support:
- All data can be used for future GHG rulemaking, EISA Anti-Backsliding report to Congress, & update of Complex Model (2009)
- Data may be used for Final Rule Making (FRM)

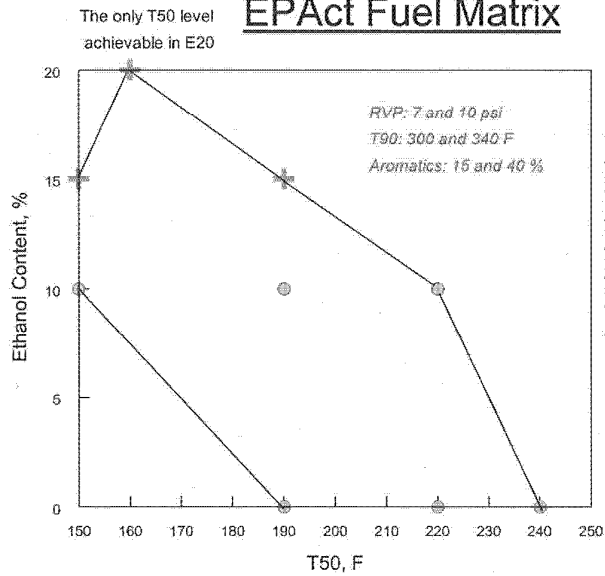
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Light Duty Gas Exhaust Fuels (SwRI)

- Objective: Phases 1 and 2 are in support RFS 2 NPRM and Phase 3 is to establish the effects of RVP, T50, T90, aromatic and ETOH content on exhaust emissions from Tier 2 vehicles
- Program Design
 - Phase 1:
 - Testing: 75°F over LA92
 - 3 'typical' fuels E0, E10, and E15
 - 19 high sales volume Tier 2, 2 high-emitter and 1 high mileage NLEV vehicles
 - Phase 2: Repeat of Phase 1 except at 50°F
 - Phase 3: Main Program
 - 27 fuels tested in 19 Tier 2 vehicles, E85 tested in 4 FFVs that are included in the 19
 - Fuel Matrix, 5 variables in matrix
 - 2 levels of RVP, T90, Aromatics
 - 5 levels of T50
 - 4 Levels of Ethanol, E0, E10, E15, E20 plus E-85
 - 2 additional fuels from CRC for resolving potential T90 non-linear effects
 - Variables span the 5th and 95th percentiles of in-use fuel properties
- Measured emissions: PM, CO₂, NO₂, VOCs, ethanol, carbonyls, N₂O, NH₃ and HCN by FTIR, and SVOC speciation in Phases 1, 2 and 3

Ethanol Content/T50 Combinations in EPAct Fuel Matrix



The addition of ethanol to gasoline causes considerable shifts in T50 ranges

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EPAct Fuel Matrix

Phase 3:
Base Program (EPA)
(Fuels 1-16)

Phases 1 and 2:
RFS 2 Subset (EPA/DOE)
(Fuels 17-19)

Phase 3:
Additional Fuels (DOE)
(Fuels 20-29)

E85 (DOE)
CRC additional Fuels

Fuel #	T50 °F	T90 °F	ETOH %	RVP psi	ARO %
1	150	300	10	10	15
2	240	340	0	10	15
3	220	300	10	7	15
4	220	340	10	10	15
5	240	300	0	7	40
6	190	340	10	7	15
7	190	300	0	7	15
8	220	300	0	10	15
9	190	340	0	10	40
10	220	340	10	7	40
11	190	300	10	10	40
12	190	340	10	10	40
13	220	340	0	7	40
14	190	340	0	7	15
15	190	300	0	10	40
16	220	300	10	7	40
17	215	325	0	9	30
18	202	325	10	9	25
19	195	325	15	9	23
20	160	340	15	10	15
21	150	300	15	10	40
22	180	300	20	7	40
23	160	300	20	10	15
24	160	340	20	10	40
25	160	340	20	7	15
26	190	300	15	7	40
27	160	340	15	10	40
28	160	300	15	10	15
29	180	180	85	180	180
30	150	325	10	10	40
31	160	325	20	10	15

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Light Duty Exhaust Fuels (SwRI) Testing Schedule

Phase	Duration	
Fuel blending	Feb. 2008	August 2008
Phase 1	Apr. 2008	June 2008
Phase 2	June 2008	Sept. 2008
Phase 3	Sept. 2008	Oct. 2009
Reporting	Oct. 2009	Dec. 2009

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Fresh Oil PM Study (NVFEL)

- Objectives: Results to impact Phase 3 of EPA study at SwRI (July)
 1. Define duration of engine oil conditioning needed to stabilize the effect of oil volatility on PM emissions, so we can randomize fuels
 2. Define the impact of lubricant interaction with fuel ethanol on PM emissions. Prefer no oil changes for duration of program.
- Program Design
 - Fuels: E0, E10, E20
 - Test vehicles: 2006 Ford F-150 (Bin 8) and 2007 Toyota Camry (Bin 5) from EG&G fleet (4,000-20,000 miles)
 - Lubrizol Corp. to provide oil and oil analysis
 - Phase 1:
 - 4-phase LA92 cycle: 2 LA92 cycles run back to back for 4 co-located samples per test
 - Mileage accumulation on dyno; blocks of 500
 - Same driver used for all tests on a given vehicle
 - Measured parameters: THC, NMHC, NOx, CO, CO2, PM, OC/EC and engine oil temp.
 - At each 500 mile interval:
 - 8 Cold start LA92 tests conducted
 - Oil sample collected for analysis
 - Phase 2:
 - Testing with E10 and E20 fuels
 - 8 Cold start LA92 tests conducted for each fuel
 - Oil analyzed for volatility and ethanol content

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Fresh Oil PM Study (NVFEL) Program Status

- Oil PM stabilization on E0 completed
 - EPA Act Phase 1 oil aging (2k) “safe” from fresh oil influences on PM
 - Conclusion: Stabilization occurs much lower mileage (.5k to 1k)
 - Likely oil time at temp relationship
 - Did not isolate to PCV (off-gassing) or cylinder surface (oil shearing)
- Completed E10 and E20 programs
 - In process of evaluating results

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PM Speciation (NVFEL/ORD-NRMRL)

- **Objective:** To determine fuel effects on PM mass, size and composition, and obtain speciated semi-volatile VOC, metals and ions, and gaseous VOC (MSATs), alcohols and carbonyls.
- **Program Design**
 - Same 3 RFS 2 fuels (E0, E10, E15) from phases 1 and 2 of main program + E85
 - 6 vehicles (+/-) similar to SwRI vehicles but not necessarily identical
 - Sampling over a single test requires raw exhaust using a proportional flow system
 - Upgrade our AVL Toxic sampler for transient operation (SVOC) collection
 - Second sampler needed for PM filters (metals and ions)
- Oil-PM Pilot study will help determine PM metals detection limits (secondary experiment)
- Time Line: Late 2008

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Nonroad Exhaust (Intertek Carnot)

- Objective: Testing 5 pairs of 2 Class 1, 2 Class 2, and 2 Class 4, national average E0 (Fuel A), an octane matched E10 with 1 psi RVP boost (Fuel B)
- Testing and Aging
 - 2 engines of each engine model
 - One aged on E0 (Fuel A)
 - One aged on E10 (Fuel B)
- Test Sequence
 - Age one of pair engine for 10 hours on fuel A, 4 emission tests on fuel A, 4 emission tests on fuel B
 - Age engine to half life (55/120 hours) and emission tests repeated
- Testing Options
 - Can add an option to test on E20 (DOE likely to do)
- Timeline: Completed in October of this year
- All engines (12) acquired
 - (4) class I, (4) class II, (4) class IV
- EPA E10 fuel delayed
 - Common with vehicle program except RVP level

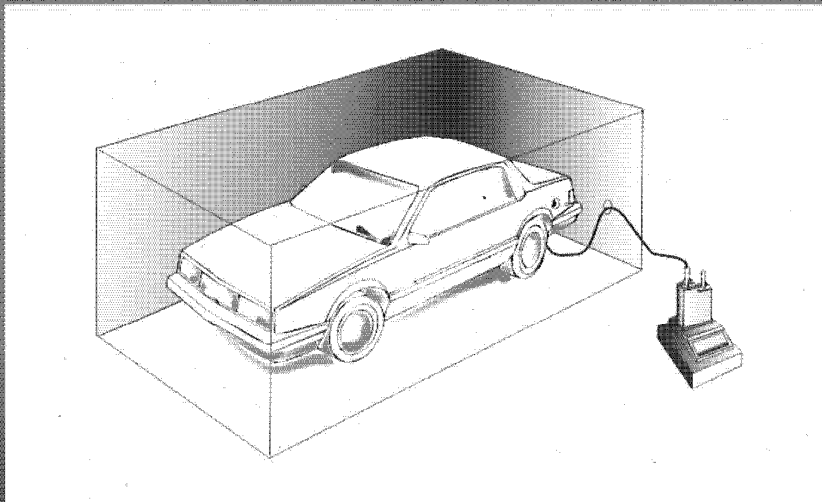
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Evaporative Testing E-77-2 (ATL)

- Program Design
 - Vehicles
 - 8 Tier 2/Near Zero
 - 2 implanted leaks
 - Fuels
 - E0, 7 and 9 psi
 - E10, 7 and 10 psi
 - E20, 9 psi funded by DOE
 - Test Plan, after 4 weeks preconditioning at each ethanol level:
 - Static permeation
 - Running loss
 - Hot soak
 - 72 hour diurnal (65°-105°F)
 - Time Line: Testing to be complete September of 2008

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Evaporative Testing E-77-2b (SwRI)

- *Objective:* Additional, newer technology, high sales volume vehicles to the CRC E-77-2
- Designated E-77-2b by CRC, EPA is the Lead
- Plan to repeat E-77-2 program with 8 more vehicles and 1 Implanted leak, without E20 fuel (unless added by DOE)
- Speciation on 100+ VOCs
- Testing at SwRI, will take ~12 mos. (complete summer of 2009)
- CRC will supply fuel which was left over from E-74b and E-77-2 programs for continuity
- CRC offered to supply 5 vehicles from E-74b program for EPA related work; all aging enhanced evap will work well here, not appropriate for the LD Gas Fuels program where required newer vehicles. (Pending CRC Board approval)

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Determine Fraction of High Evaporative Emissions Vehicles in Fleet, E-77-3 (ERG)

- **Objective:** Find the percentage of high emitting evaporative emission vehicles in the average fleet of on-road motor vehicle passenger cars and light trucks.
- **Pilot Program:** propose and refine test procedure (Colorado)
 - 100 vehicles
 - Pre-screen using RSD
 - Evaluate several methods including portable SHED
- **Main Program (Texas)**
 - Do measurements on ~1000 vehicles
 - Apply protocols developed in pilot
- **ICR**
 - Specific to this project
 - Pilot must take place this summer; expediting OMB approval process
- **Collaboration**
 - Colorado Department of Public Health and Environment (CDPHE)
 - Offering RSD and technical expertise
 - CRADA in process
 - CRC

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E-77-3 Program Plan

- **Pilot:**
 - **RSD Investigation**
 - Check Efficacy of using RSD on simulated fleet
 - CDPHE has done preliminary work
 - Optimize the use of RSD for initial screening for Evap
 - Methodology
 - RSD 3000 only "sees" exhaust HC
 - RSD 4000 "sees" both exhaust and evap HC
 - Using both in tandem allows us to look for the high evap emitters
 - **Field Validation**
 - Use RSD method in CO I/M Lane to recruit ~100 vehicles in a stratified sample for further evaluation
 - Modified CA Leak check method
 - Hand wand check with Sierra monitor
 - IR Camera
 - Temporary SHED to measure quick Hot Soak
 - Using the other tests on the selected sample we will have data on how each performs
- **At the end of the pilot we will develop a plan for a larger study in the Fall**

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Preliminary CDPHE RSD Data using RSD 4000 Instrument

Evap Test

